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# *An Abſtract of a Letter from Mr.* Anthony Leeuwenhoeck *of* Delft *about Generation by an* Animalcule *of the Male ſeed.* Animals *in the ſeed of a* Frog. *Some other Obſervables in the parts of a* Frog. Digeſtion, *and the* motion *of the* blood *in a* Feavor.

HAving been ſollicitous to examine the generation of *Frogs*, upon the account of their young ones being like a Worm, with a round thick body and a ſhort tayle: I was ſurprized to find that the *Male* was not joyned to the *Female* in Copulation, but that he only ſate upon her; and had no *Membrum Maſculum*: that at the ſame time when the *Famale* caſt her *Eggs* or *Spawn*, the *Male* alſo dropt his *Seed*; which is to be ſpread under the *Eggs*: in like manner as the Seed of *Fiſhes* that want the *Membrum Maſculum* is caſt under the *Eggs* of the *Female*, that the *Animalia in ſemine* may conveniently impregnate the eggs. For I hold it neceſſary that ſome one of the Animals *in ſemine* ſhould get into a certain * *point* of the yoak of the *egg* (which *point* is only fit to receive it, and give it the firſt Nouriſhment, till ſuch time as the *Egg* comes to be ſat on) But if no one *Animal* ſhould find this *point*, then the Egg is unfruitful: and this may be a reaſon why there are ſo many thouſand more Animals *in ſemine Maſculo*, then *Eggs* in the *female*.

In ſeveral of my Obſervations I had not found the *Animals* taken out of the *Teſticles and Vaſa Deferentia* of Froggs to be alive. But on the firſt of *April* when Froggs were ready to ſpawn, I took ſome of the *Males* ſitting upon the *Females*, and ſqueezed their hinder parts that I might get the ſeed out of the *Vaſa deferentia* but the *Animalcules*

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* By this point or ſpeck he means the Cicatricula.

*malcules* I then found, moved but little, becauſe the matter they were in was full of ſalt particles, which made me judg it to be *Urine*.

I then cut open the *Teſticles* and there I found an innumerable company of *Animalcules* ſwiming among a ſort of ill ſhapen particles, theſe continued alive till the next day, tho there were but a ſmall quantity of liquor to contain them.

I judge the Bodies of the *Animalcules* to have been of the thickneſs of $\frac{1}{1000}$ part of a hair of my head: If the matter they moved in had not been ſo thick I ſhould have ſeen them much plainer, nevertheleſs they are repreſented to the beſt of my skill in *Fig. firſt* where A B C is an *Animalcule* as it lay in the Watry matter, and moved it ſelf therein, ſometimes the head appeared to be thicker then other times, and often I could ſee the Body but from A to B by reaſon of the thinneſs of the Tail BC. when the Animal moved it ſelf ſtrongly, tho the progreſs were but little, the motion towards the head was like that of a Snake, and the tayle was caſt into 3 or 4 Bows. *Fig.* D is an Animalcule lying dead, and ſtretcht out at length, but in this poſture I ſaw but few, for many that were dead lay with the fore part of their body bent in, as in *Fig.* E others made as, it were a half circle others had the forepart of their Body bent and moved their hinder parts: theſe laſt I took to be ready to dye.

The number of *Animalcules* in all the ſeed was ſo great that I judge there might be 10000 of them to one of the *Females* Eggs, the ſame computation I formerly made of the *Milt* of a *Codfiſh*, but it muſt not be thought that all the *Animals* in the *Milt* of the *Codfiſh* live together, but only ſuch of them as are neareſt the paſſage they are to be caſt out of, and who have more moyſture about them; the reſt of them being more remote in the body, and being incompaſſed with a thicker matter, are not alive; for tho ſome *fiſhes*, as the *Breame*, and *Trout*, caſt their Milt and Spawn in two days time, yet *Codfiſhes* are about a *Moneth* in doing it; in all which time the ſeed is ſucceſſively ripened and perfected. So alſo are *Froggs* by what I have experienced, for the firſt *Animals* I ſought were dead, and though I afterwards found live ones, yet thoſe were dead that lay deepeſt in the *Teſticle*.

Tis well known that when a *Cock* hath trod a *Hen* but once, many *Eggs* are made fruitful, the reaſon that I give for it is, that many of the *Eggs* in the *Ovary*, have each of them received an *Animalcule* out of the *Male ſeed*. This *Animalcule* while the *Egg* is ſate upon does not preſently take the figure of a *Chick*, but grows into a diſorderly Bulk, wherein the heart is firſt plainly to be diſcerned. Other *Fœtus's* have a different way of growth, the *Louſe* has all its parts, and is a *Breeder* while it is yet in the *Egg*; the *Flea* ſhows like globules ſwimming in a watry ſubſtance, it afterwards becomes a *Worm*, then a *Nympha*. The *Frog* is a thick *Worm* till it be of a conſiderable bigneſs. The *Humane Fœtus* tho no bigger then a *Green Pea*, yet is furniſhed with all its parts. I have often endeavoured to diſcover the *Animal* coming out of the *Male ſeed*, in the egg of the *Hen*; but have been unſucceſsful tho ſome of the *Globules* of the *Egg* were magnified ro the bigneſs of common Apples. This diſappointment has put me upon the Eggs of *Inſects* as the *Flea*, and *Louſe*, which being very ſmall, may be ſo much the fitter for this diſcovery.

A certain *Phyſician* writing of Generation ſets down theſe words, in the Margent *from the female ſeed the fruit muſt grow however the thing came to paſs*. This he inlarges upon in the *Text*, but I think under correction that by one inſtance I ſhall bring a ſufficient proof of the fruits coming from the *Male ſeed*, and the *females* only contributing to the nouriſhment and growth of it. Many of our *Neighbours* either for their pleaſure or profit, keep tame *Rabbits*, which are large long eard, ordinarily of a white colour, but ſometimes of a Blew, Black, and Pyed; thoſe that would make a proffit of theſe *Rabbets* by cauſing them to bring gray young ones, which in the fore part of the year may be ſold for a wild kind; get a *grey Male*, ſuch as are ordinarily found on our *ſand hills*, to pnt to their female: The *Breed* that comes from hence always takes the gray colour of the *Male*, and it has never been ſeen that any of the young has had any *white*, or other coloured hair then *gray*, there withal they are never ſo bigg as the *Dam*, nor have ſo great ears, nor are ſo tame, but of a wilder kind.

The firſt *Frog* which I anatomized lay on the ground in my way, and ſeemed ſo weak through cold that tho I kicked it with my foot, it would not leap away, this proved a *Female*, in the gutts of it I found *worms* like thoſe in *Children* of about the thickneſs of a hair of my head. The blood conſiſted of flat oval particles, ſwiming in a clear liquor: theſe had no colour as they lay ſingly, but when 2 of them lay upon one another, as here *Fig. 2d.* their colour was ſtronger. A is an *Ovale* of blood partly covered with B a *2d. Ovale* of blood, C is a *3d. Ovale* of blood covering a part of ACB as at D. and caſting a deeper colour, by reaſon that 3 *Plates* lye upon one another: But there was another ſmall *Oval* hard by repreſented by E which ſhowed of a higher red then the three *Plates* together. Many of theſe *Ovale* particles were very pleaſant to look upon, eſpecially when the moyſture wherein they ſwam (having alſo *Globules* on the ſurface as big as $\frac{1}{6}$ of a *blood Globule*) was evaporated; for ſome had in the middle a faint *Ovale* ſhade, others appeared as if they were made of ſeveral *Ovales* of unequal bigneſs, others ſeemed to be ſet round with ſmall *globules*, others had no *globules* in the Circumference, but ſeveral in the middle: theſe *Globules* I believe were at firſt ſwimming in the Watry liquor under the *Ovales*, tho now they cleave to them by Accedent.

Upon the Plate whereon I layd the Frog that I anatomized I found ſeveral *Animals* moving in a watry blood, they were about half as long and half as broad as the *Oval Particles*, and about 50 of them might lye in the ſpace of a ſand, theſe I had never ſeen in the pure blood, nor could I perceive them in the water that came out upon ripping the skin from the fleſh, or upon opening the belly, or ſqueezing the head of the *Frog* to make it lye quiet upon the *Plate*. At length in the moneth of *June* I met with ſome *froggs* whoſe excrement was full of an innumerable company of living Creatures, of different ſorts and ſizes, the greateſt ſort were ſhaped like *Fig.* F and of theſe I judged that 40. might be in the ſpace of a ſand. The 2*d.* ſort had the ſhape of *Fig.* G. theſe were but few in number. The 3*d* ſort was like our River Eeles as *Fig.* H. and theſe were more in number then the firſt; But the whole excrement beſides was ſo full of living things, that it ſeemed all to move, & I gueſt there was not leſs then 1000 of the third ſort in the ſpace of a ſand. From hence I concluded that the *Animals* found among the blood might come from my cutting a Gut.

By the way I obſerved ſomething of the dammage that *frogs* may do to *fiſh-ponds*, for I took out of ſome of their *Stomacks* 8. 10 or more young *fiſhes*.

I took notice of a ſmall vein, of about the thickneſs of a hair of my head, that when the blood was out of it, the Coat was like a *frogs* outward skin.

The ſame Coat of the vein was made of threds or *filaments* runing by the ſide of one another, juſt as if they had been wound cloſe about a ſmall round ſtich, ſo as to cover it all over. Now if there be *Capillarys* in the body a 1000 times leſs then this which I examined, how thin muſt the threds neceſſarily be of which the Coat is made? and how eaſily muſt theſe threds be ſeparated and devided from one another, ſo as to let the blood when it is very forcibly moved in the *Arterys*, ſtart out between them; and I was the more confirmed in this Opinion, upon ſpreading hard the Coat of the vein, for I then ſaw through it as through a hair ſive, hence may a probable account be given of *St. Anthonys fire*, red *ſwellings*, or

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the *Small pocks*, and perhaps the blood may be more gently ſtrained through theſe paſſages for the nouriſhing of ſome parts of the body.

I examined one of the *Muſcles* of the hinder leg of a *frog*, which conſiſted of *filaments*, and thoſe again of a great number of leſſer *filaments*, but becauſe they had more rings in them then I had formerl ſeen in the muſcular threds of an *Oxe*, *Fly*, *Gnat*, *Flea* or *Louſe*, I have here repreſented part of one in *Fig*.I. ſuch numerous rings I have ſince met with in the *filaments* of the *Muſcle* of a *Lamb*, taken from the rim of the Belly, near the hinder leg. From the indentings of theſe *filaments* I cannot only ſatisfy my ſelf how the *limbs* come to ſtand bent, when the *muſcles* are at reſt, but alſo why we can walk a longer time then ſtand ſtill; and why our *Arms* when we walk do not hang down at their full length, ſtretcht out by our ſides; but more backwards and forwards; for if the *Arms* ſhould ſtill hang ſtrait down, then would one *Muſcle* be ſtretcht too much, and another bent or drawn up too cloſe; both theſe things diſagreeing with the Natural conſtitution of the *Muſcle*, and for this reaſon it is, that when we ſtand a long time, we do not reſt equally upon both legs, but firſt raiſe up one foot, then the other, touching the ground only with the fore part of the foot, while the *Muſcles* of that leg reſt themſelves.

I have been puzzled why ſome of the wrincles in the *filaments* of Fleſh and Fiſh *muſcles*, were *ſerpentine*, as I repreſented in my letter of the 3*d*. of *March* (*Fig*. 1*ſt*. E E G H and I K L M.) but I conſider that the *filaments* loſe their roundneſs by being preſt hard upon one another. It is alſo probable that they may be bent after that manner by the evaporating of their moyſture, which makes up $\frac{2}{3}$ parts of their bulk: as *Fig*. K. α β γ δ. is a Filament which had been round, but is now alterd by the evaporating of its moyſture, and bended in as at α, whereby the rings that were formerly ſtreight; appear ſerpentine, as between β and γ.

In a letter of mine to Mr. *Oldenburg* (which was not publiſhed) I affirmed, that *Concoction* was not performed by an *Acid liquor* diſſolving our meat, but by the *motion* of the *Stomach*, and *guts*, which bruiſes, and breaks the meat to pieces. This motion is cauſed by the *Diaphragme* preſſing upon the parts of the lower belly, as often as we take *breath*; in the ſame manner as a bladder almoſt full of water, is molded and rolled between the hands. There is alſo a natural *warmth* to be conſidered in the *ſtomach*, and a natural *folding* or cloſing it ſelf, about the *Victuals* which it holds, be it never ſo little; but eſpecially there is a kneeding or contracting of themſelves, remarqueable in the Bowels of beaſts, even after they are taken out of the body. I am lately more confirmed in this *opinion*, by my *obſervations* on the *Excrements* of a *Codfiſh*. which I find to be made up of very ſhort pieces of the *Filaments* of *Fiſh*, appearing by the *Microſcope* like the ſhavings of ones Beard, for as in ſome Creatures the taking of *breath*, ſo in fiſhes the moving of the *Gills*, cauſes a compreſſion and dilatation in the *ſtomach*, whereby the *Aliment* is catcht in its folds, nipt a ſunder, and divided into ſuch ſmall particles as are fit for the nouriſhment of their bodies. Now if the *Contraction* of the *ſtomach* be ſuppoſed to happen no oftner then a man *breaths* in an hour, there will be about 3000 times: which will be quickly enough to waſt, and tear in pieces a little fiſh ſwallowed down by a great one, although the teeth of the *Devourer*, and the *Acid juice* ſhould contribute nothing to *digeſtion*.

Sometimes theſe threds are not to be found in the *excrements*, as perhaps when the *Codfiſh* has been long catcht; and without food, for then the threds are broken ſo ſhort; that they are no bigger when they are voyded, then ſmall *Globules*, which I judged to be $\frac{1}{6}$ of a *blood Globule*. When the *Codfiſh* has abundance of food, then the pieces of threds are droven the faſter out of the *ſtomach*, and through the *Bowels*, and therefore are the leſs broken and ſhortned.

Such like *Filaments* or pieces of fleſh I have obſerved in my one *Excrements*, which I conceive were made by the nipping of the *folds* of the *ſtomack*: for theſe *Filaments* are not ſtrong, when there lye yut few of them together; or when we make a *Cord* or *Rope* of them, which upon ſtretching bears unequally; though in another caſe a *muſcle* made up of ſeveral of theſe *filaments*, and bearing epually in every part, may be very ſtrong.

I have often maintaind among our *Pyhſicians*, that tho the heart and Pulſe beat quicker then ordinary, yet the *Circulation* of the *blood* is not performed in leſſer time; and the reaſons which I gave were theſe. The blood in many *Feavoriſh perſons* is very thick, and therefore paſſes ſlowly, and with difficulty, thro the ſmaller *Arterys*, and requires a very ſtrong beating in the heart to force its way. When the blood is thick and makes this reſiſtance, the heart upon contracting it ſelf, cannot force it all out, but a great part remains behind in the *Ventricles*. This remaining blood being over heated by the heart, makes that little blood which comes freſh out of the Veins, too hot likewiſe; and in the mean time the heart not being able to free it ſelf of all the blood contained in its *Cavities*, caſts out only the thinner part, which is quickly ſpent in the nouriſhment of the body, whereby the blood ſtill becomes thicker, and *circulates* leſs faſt. I can not admit that the time of the *circuite* of the blood, ſhould be eſtimated by the number of *Pulſes* in an hour, and the capacity of the *Cavitys* of the heart; for as the *Lungs* upon expiratiou are never totally without air, ſo the heart in a well conſtituted body, is never upon the *Siſtole* abſolutely with out blood: I imagine alſo that when the *heart* is too full of *blood* (as I have before urged) its muſcles may be ſo far ſtrained, and kept beyond their uſual bent, that they would not be relaxed, tho the blood were very thin, and fit for motion; juſt as we ſee the *bladder* by being kept long too full of *water*, has the *Muſcles* ſo reacht, that they can not be contracted. So alſo the *Eaſterne People* who would acquire to themſelves the reputation of *Saints*, remain with their *Limbs* ſo long ſtretcht out in one poſture, that they can not draw them back again.

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Philoſoph. Tranſact. Number, 152.

Fig:1.

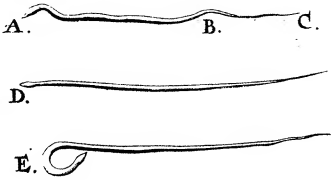
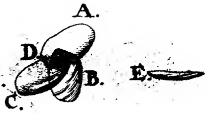
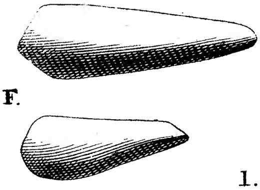


Fig. 2.




F.

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